algae and epiphytes from seagrass blades. As the population of *D. antillarum* recovers and if fishing management practices curb overfishing, the re-establishment of large herbivores is likely to dramatically affect resource partitioning among large and small herbivores in reef flats.

Literature Cited

Lessios, H.A. 1988. Mass mortality of *Diadema antillarum* in the Caribbean: What have we learned? Annual Review of Ecology and Systematics 19: 371-393.

Lobel, P. S. and J. C. Ogden. 1981. Foraging by the herbivorous parrotfish *Sparisoma radians*. Marine Biology 64: 173-183.

Paul, V. J. and K. L. Van Alstyne. 1992. Activation of chemical defenses in the tropical green algae *Halimeda* spp. Journal of Experimental Marine Biology and Ecology 160: 191-203.

Rutar, T., J. Shandro, E. Sohn and A. Williams. 1997. Density dependent herbivory on *Thalassia testudinum*. Pp. 136-138 *in* J. Shandro editor. Dartmouth Studies in Tropical Ecology 1997. Dartmouth College: Hanover, NH.

Diel variation in fish community composition and habitat distribution in Discovery Bay, Jamaica

Laura R. Nagy, Marc N. Conte, Cheryl B. Shannon, Ashley C. Brown, and 2000 Dartmouth FSP class

Abstract: The partitioning of resources on a diel and spatial scale allows more species to coexist in an area than otherwise could occur. To examine the hypothesis of diel resource partitioning, we conduced day and night fish censuses in Discovery Bay, Jamaica. We found 102 species of fish; 36 species found only during the day, 27 species found only at night, and 39 species found during both day and night. The large number of species found exclusively in day or night suggests that species are temporally segregated allowing for greater resource partitioning. In addition, habitat usage varied between day and night, suggesting that species present during both times may still be partitioning resources temporally through differential habitat usage at different times. The resource partitioning provides one potential explanation of the high diversity of tropical coral reef ecosystems.

Key Words: resource partitioning, fish community

Introduction

The ability of tropical coral reefs to support high fish diversity is well documented; however, the mechanism behind this pattern is currently unresolved. One explanation put forth to explain such high diversity is resource partitioning among species, which potentially allows many species to exist in the same geographic area without overlapping resource use, or niches (Gutierrez 1998, Pitts 1991). Partitioning of resources can occur on either a temporal (e.g., day/night) or a spatial scale (e.g., between habitats). If species partition resources on a diel scale, we predict a difference in species composition between day and night fish assemblages. If fish species partition resources spatially, we predict that species will be associated with specific substrates.

Methods

We surveyed the species composition and habitat distribution of fish on the back reef in Discovery Bay, Jamaica. Data were collected from nine transects that originated at the Discovery Bay Marine Laboratory boat launch and ended at the reef crest (Figure 1). Each transect was censused over 1 hour at both 10:00 and 20:00 on 27 February 2000. We noted each time that a fish species was seen in each of six habitat categories (sand, algae, seagrass bed, patch reef, reef, and hiding under crevice) for the first time. For each transect, fish were recorded as present or absent in each habitat but no attempt was made to quantify abundance. Rather, the number of transects in which species were seen was used as a measure of relative abundance. To analyze temporal differences in the proportion of transects in which species were seen, we used separate 1-way ANOVAs for each habitat type to compare the relative abundance between day and night samples. These analyses were repeated for species seen 1) only at night, 2) only during the day, 3) both night and day, and 4) all species across time periods. For species found on greater than five transects, we compared the relative distribution of fish across habitats (grouped as vegetation, sand, reef, and hiding under crevice) between day and night using a contingency analysis. This was also done for species observed to have differences between day and night habitat distributions.

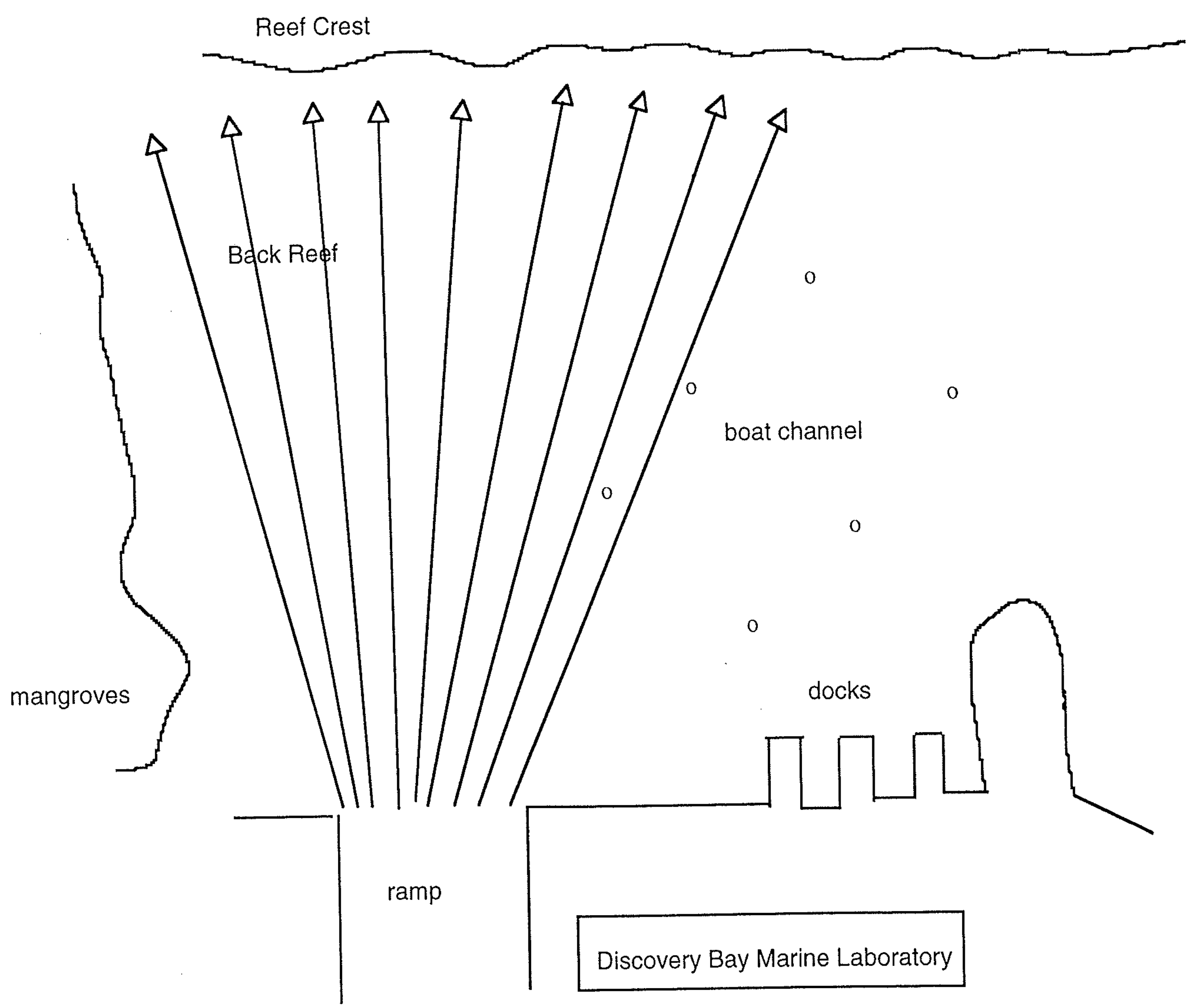

Figure 1. Map of disturbed and undisturbed sites in Discovery Bay, Jamaica. (Drawing is not to scale.)

Results

We observed 102 different fish species, with 36 species found exclusively during the day, 27 species found exclusively at night, and 39 species found both during the day and at night (Table 1). Across all species, the proportion of transects on which species were seen was significantly different between day and night for patch reef and back reef habitats (Figure 2; $F_{1,78} = 9.12$, $p = 0.003$; $F_{1,78} = 16.68$, $p < 0.001$, respectively). Eight of the 39 species found in both day and night transects were found in multiple day transects but only one night. Of these eight species two were only found at night hiding under crevices. Seven of the 39 species were found in multiple night transects but only one day transect. Longjaw squirrelfish, squirrelfish, redband parrotfish, and bicolor damselfish (four of 12 species selected for contingency analysis) showed significant differences in habitat use between day and night (Table 2).

Discussion

Species composition differed between day and night, suggesting temporal partition-

Table 1. Fish sighted during day and night surveys on the back reef at Discovery Bay, Jamaica. Number of transects indicates the number of transects out of 9 per time period in which fish species were seen.

Day Only		Night Only	
Species	# transects	Species	# transects
ANGELFISH, FRENCH	2	ANCHOVY, DUSKY	1
BARRACUDA	1	BASS, HARLEQUIN	1
BASS, CONEY	2	BURRFISH, BRIDLED	2
BASSLET, FAIRY	3	BURRFISH, WEB	1
BLENNIES	1	CARDINALFISH, BARRED	2
BLENNY, REDTIP	1	CARDINALFISH, BELTED	2
BUTTERFLYFISH, BANDED	1	CARDINALFISH, BIG EYE	1
BUTTERFLYFISH, FOUREYE	2	CARDINALFISH, BIGTOOTH	1
CORNETFISH	1	CARDINALFISH, BRIDLE	2
DAMSELFISH, YELLOWTAIL	6	CARDINALFISH, DUSKY	2
DURGON, BLACK	1	CARDINALFISH, FLAMEFISH	4
FLOUNDER, CHANNEL	1	CARDINALFISH, TWOSPOT	4
GOATFISH, YELLOW	4	CARDINALFISH, WHITESTAR	1
GOBY, CLEANING	1	EEL, GOLDENTAILED MOREY	1
GOBY, NEON	1	EEL, SHARPTAIL	2
GOBY, SHARKNOSE	2	EEL, SNAKE	1
GOBY, YELLOWNOSE	1	EEL, VARIEGATED MORAY	1
GRUNT, TOMTATE	3	FILEFISH, SCRAWLED	1
HAMLET, BUTTER	2	GRUNT, SMALLMOUTH	1
JACK, BAR	5	LIZARDFISH, BLUESTRIPED	1
JACK, HORSE EYE	1	PERCH, SAND	2
MOJARRA, SLENDER	1	RAY, LESSER ELECTRIC	3
NEEDLEFISH, HOUNDFISH	1	SARDINE, SCALED	1
PARROTFISH, BLUELIPPED	1	SARDINE, SPANISH	1
PARROTFISH, BUCKTOOTH	5	SNAPPER, GLASSEYE	1
PARROTFISH, REDFIN	5	SQUIRRELFISH, REEF	4
PUFFER, SHARPNOSE	1	SWEEPER, GLASSY	2
SCORPIONFISH, PLUMED	1		
SCORPIONFISH, SPOTTED	1		
SEA ROBIN, BANDTAILED	1		
SEAHORSE, LONGSNOUT	1		
SURGEON, BLUE TANG	7		
TRUNKFISH, SMOOTH	2		
WRASSE, BLUEHEAD	9		
WRASSE, CLOWN	2		
WRASSE, YELLOWHEAD	3		

ing of resources. Sixty percent of the species were found only during the day or only during the night, indicating two non-overlapping fish assemblages, as would be expected if resources were being partitioned. However, many fish species were seen at both day and night, suggesting that species may engage in different behaviors during the two time periods. This result could be due to feeding patterns, predator avoidance, or sleeping versus active periods. For example, herbivores such as parrotfish and damselfish, that feed during the day (Lewis 1985), were found hiding under crevices/resting at night more than expected if randomly distributed across habitats (Table 2). These patterns differed for species feeding on nocturnal prey. For example, squirrelfish were over-represented during the

Table 1: Continued:

Both Day and Night

Species	# transects Day	# transects Night	Species	# transects Day	# transects Night
DAMSELFISH, BEAUGREGORY	7	1	PARROTFISH, REDBAND	3	1
DAMSELFISH, BICOLOR	8	1	PARROTFISH, REDTAILED	1	2
DAMSELFISH, BROWN CHROMIS	2	1	PARROTFISH, STOPLIGHT	9	2
DAMSELFISH, DUSKY	9	5	PARROTFISH, STRIPED	8	2
DAMSELFISH, SERGEANT MAJOR	8	3	PUFFER, BALLOONFISH	8	8
DAMSELFISH, THREESPOT	5	2	PUFFER, PORCUPINE FISH	1	6
EEL, GOLDSPOTTED	2	2	RAY, YELLOW STING-	1	6
EEL, SPOTTED MORAY	1	2	SAND DIVER	4	1
GOATFISH, SPOTTED	8	1	SILVERSIDE	3	5
GOBY	1	1	SNAPPER, YELLOWTAIL	5	1
GOBY, BRIDLED	4	2	SOLDIERFISH, BLACKBAR	1	3
GRUNT, BLUESTRIPED	5	3	SQUIRRELFISH, LONGJAW	5	9
GRUNT, FRENCH	8	3	SQUIRRELFISH, DUSKY	2	3
HAMLET, BARRED	1	2	SQUIRRELFISH, LONGSPINE	1	3
HAMLET, INDIGO	5	1	SQUIRRELFISH	8	5
MOJARRA, MOTTLED	3	4	SURGEON, DOCTORFISH	9	7
MOJARRA, YELLOWFIN	3	4	SURGEON, OCEAN	7	4
NEEDLEFISH, FLAT	2	1	TRUMPET FISH	6	1
NEEDLEFISH, REDFIN	1	1	WRASSE, SLIPPERY DICK	7	1
PARROTFISH, PRINCESS	6	1			

day and underrepresented at night in open habitats (Table 2). This difference indicates that feeding and refuge habitats differed temporally. Alternatively, predation pressure may alter habitat use patterns. During the day, there were more fish in areas that provide shelter from predators (i.e., the reef crest and patch reefs). In contrast, areas with high potential food resources but limited cover had more fish present at night (i.e., grass and sand).
Thus, it appears that fish partition resources on both a diel and spatial scale. This partitioning results in different species assemblages during the day and at night. This partitioning may play a role in the high diversity of tropical fish communities and contribute to understanding the high diversity found within coral reef ecosystems as a whole.

Literature Cited

Gutierrez, L. 1998. Habitat selection by recruits establishes local patterns of adult distribution in two species of damselfishes: *Stegastes dorsopunicans* and *S. planiforns*. Oecologia 115: 268-277.

Pitts, P. A. 1991. Comparative use of food and space by three Bahamian butterflyfishes. Bulletin of Marine Science 48 (2): 749-756.

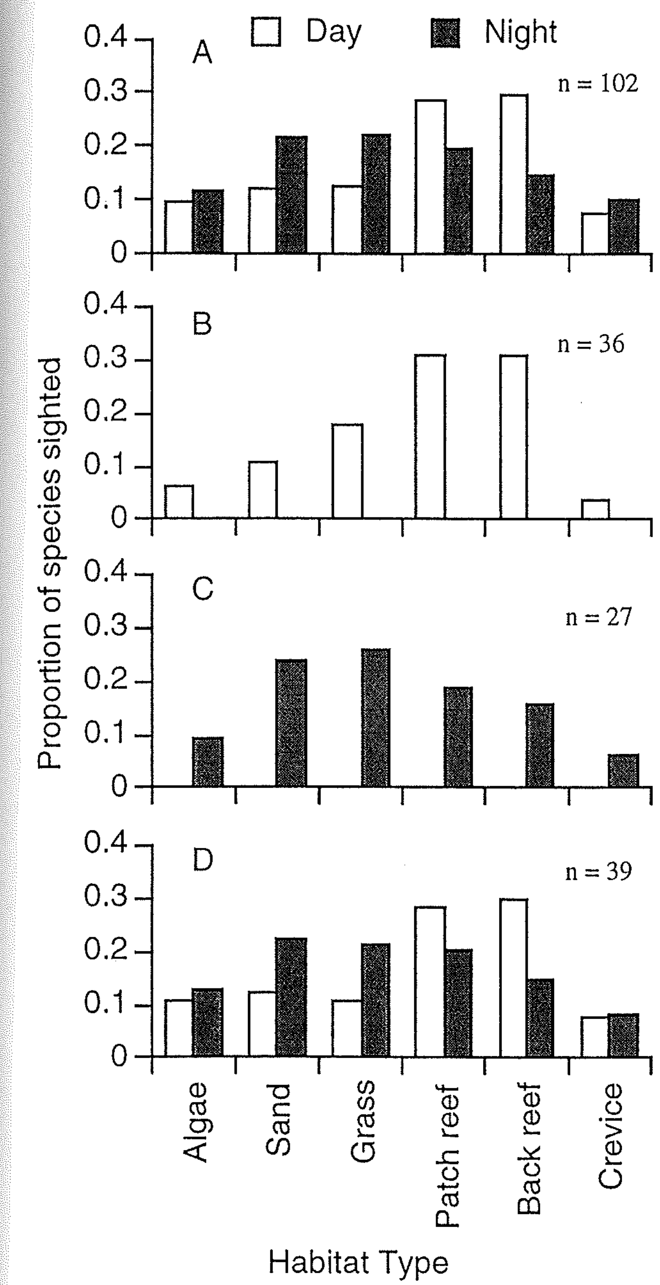

Figure 2. Habitat occupied by fish species observed during day and night surveys on 27 February in Discovery Bay, Jamaica, for (A) all fish seen in all surveys, (B) fish seen exclusively in the day, (C) fish seen exclusively at night, and (D) fish seen in both day and night surveys.

Table 2. Results from contingency analysis testing the hypothesis that the distribution of fish across habitats was the same during the day and at night. For species with p values < 0.10, habitat types with high contributions to the G statistic are listed. Up arrows indicate habitats that were over-represented and down arrows indicate habitats that were under-represented. Habitats were classified as either vegetation, reef, under crevice (hiding), or sand.

Species	G	p	Night	Day
Balloonfish	2.65	0.45		
Damselfish, bicolor	4.95	0.08	↑ hiding	
Damselfish, dusky	5.53	0.14		
Damselfish, sergeant major	2.26	0.52		
Damselfish, three spot	2.64	0.45		
Parrotfish, princess	0.42	0.81		
Parrotfish, redband	8.38	0.02	↓ reef, ↑ hiding	
Parrotfish, stoplight	5.92	0.12		
Parrotfish, striped	4.11	0.25		
Squirrelfish	11.90	0.001	↑ veg., ↑ sand,↓ hiding	↓ veg., ↓ sand
Squirrelfish, longjaw	16.72	0.001	↓ hiding	↑ hiding
Squirrelfish, dusky	6.14	0.10		
Squirrelfish, longspine	4.53	0.10		